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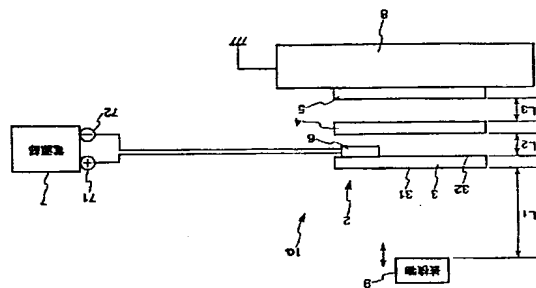
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(54)【発明の名称】 静電容量センサ

## (57) 【要約】

【課題】検出電極の大きさにかわらず、検出精度が高  
かつ感度が高い静置容量センサを提供する。

【解決手段】前記電圧増設部1aは、静電容量型の抽出端子2と、抽出回路が実装された回路基板6と、電源部7とで構成されている。抽出端子2は、抽出電線3と、抽出電線4と、アース電線5とで構成されている。帯電板4から抽出電線3とアース電線5との間に位置し、これら4から抽出電線3、帯電板4およびアース電線5は、互いに絶縁された状態で配置されている。抽出電線3、帯電板4およびアース電線5は、それぞれ、端部において図示しない絶縁材（支持部材）により支持されている。回路基板6は、抽出電線3の面3.2に設置され、帯電板4から接続されている。



## 【特許請求の範囲】

【請求項1】 検出電極と、アース電極と、前記検出電極とアース電極との間に位置する少なくとも1つの帯電反とが互いに絶縁された状態で配置された静電容量型の検出素子と、

食出回路と、  
前記検出回路に電力を供給するための電源部とを有する  
とを特徴とする静電容量センサ。

【請求項2】 前記アース電極は、前記電源部のマイナ  
ス側端子に電気的に接続されている請求項1に記載の静  
電容量センサ。

【請求項3】 前記アース電極は、中継回路を介して前記電源部と接続され、前記電源部のマイナスイ側端子に電気的に接続されている。第1電圧センサ。

【請求項4】 前記中継回路が抵抗を有する請求項3に  
記載の静電容量センサ。

【請求項5】 前記抵抗が可変抵抗である請求項4に記載の制御装置センサ。

【請求項6】 前記中継回路がコンデンサを有する請求項3ないし5のいづれかに記載の静電容量センサ。

【請求項7】 前記コンデンサが可変コンデンサである。

【請求項8】 前記中継回路は、静電容量センサの感度係数を前記請求項3に記載の解読率に設定する機能を有するものである請求項3に記載の解読装置。

【請求項9】 前記中継回路は、静電容量センサの感度低下を検出する機能を有するものである請求項3または8に記載の静電容量センサ。

【請求項10】 前記帯電板と前記アース電極との間の距離の設定により、静電容量センサの感度を設定するよう構成されている請求項1ないし9のいずれかに記載の静電容量センサ。

【請求項1】 前記帯電板と前記アース電極との間の距離が、前記検出電極と前記帯電板との間の距離より少なくとも10%大きい請求項1ないし10のいずれかに記載の静電容量センサ。

【請求項12】 前記検出回路は、前記検出電極の検出出力と、前記検出電極の検出出力を反転させた出力との両方を用いて、前記検出電極の検出出力が所定の閾値に達したことを検出する。

【請求項13】 複数の帯電板が検出素子の厚さ方向に沿って配置されている請求項1ないし12のいずれか1に記載の静電容量センサ。

【発明の詳細な説明】

【1000】  
【先多】

【発明の属する技術分野】本発明は、静電容量センサに関する。

[0002]

【従来の技術】被検物の接近を検出する静電容量センサは、電極部と

この電極部に接続された検出回路とで構成されている。  
前記電極部は、被検物の接近を検出するための検出電極と、所定の部位に接地されたアース電極とで構成されている。

【0003】このような静電容量センサでは、被検物が検出電極に接近すると、検出電極の静電容量が増加するので、検出回路により前記検出電極の静電容量の変化を感知する。

【0004】しかしながら、実際には、静電容量センサでは、検出電極の静電容量のみでなく、電阻部全体の静電容量、検出回路の静電容量等が検出され、しかも、これらの静電容量は、温度や湿度、あるいは振動等の何らかの外的環境の変化により変動し、それがノイズとなるので、検出精度が低い。そして、外的環境が変動することによって、検出精度が低下することがある。特に、静電容量センサを屋外で使用する場合には、季節や時間帯、あるいは温度や湿度が大幅に変動するの

【0005】また、前記従来の静電容量センサは、電極部自体の感度が低いとともにその感度が不安定であり、このため、検出電極から被検物までの検出距離（以下、単に「検出距離」という）を長くすることが困難であった。

【0006】特に、検出電極の検出面の面積が大きい  
程、前記目的環境の変動による電極部の静電容量の変動  
が大きくなり、これによりノイズが増大するので、静電容量  
センサの検出精度が低い。そして、検出電極の検出面  
面積が比較的大きい場合には、前記検出電極を向上させ  
るために、検出回路におけるしきい値を高く設定するの  
が必要であった。

【0007】

【発明が解決しようとする課題】本発明の目的は、検出電極の大きさにかかわらず、検出精度が高く、かつ感度が低い静電容量センサを提供することにある。

100081

【課題を解決するための手段】このような目的は、下記

【0000】(1) 検出電極と アース電極

【0005】(1) 検出回路は、検出電圧とアース電極との間に位置する少なくとも1つの検出電極とアース電極とが互いに絶縁された状態で配置された検出電極の帯電電圧と、被検物による前記検出電極の静電容量型の検出電圧と、被検物による前記検出回路に電力を供給するための電源部とを有することを特徴とする静電容量センサ。

【0010】(2) 前記アース電極は、前記電源部のマイナス側端子に電気的に接続されている上記(1)に記載の修正容量センサ。

【0011】(3) 前記アース電極は、中継回路を介して前記電源部のマイナスイ側端子に電気的に接続されて

いる上記(1)に記載の静電容量センサ。  
【0012】(4) 前記中継回路が抵抗を有する上記(3)に記載の静電容量センサ。

【0013】(5) 前記抵抗が可変抵抗である上記(4)に記載の静電容量センサ。

【0014】(6) 前記中継回路がコンデンサを有する上記(3)ないし(5)のいずれかに記載の静電容量センサ。

【0015】(7) 前記コンデンサが可変コンデンサである上記(6)に記載の静電容量センサ。

【0016】(8) 前記中継回路は、静電容量センサの感度を安定させる機能を有するものである上記(3)または(8)に記載の静電容量センサ。

【0017】(9) 前記中継回路は、静電容量センサの感度を安定させる機能を有するものである上記(3)または(8)に記載の静電容量センサ。

【0018】(10) 前記帯電板と前記アース電極との間の距離を設定により、静電容量センサの感度を安定させるよう構成されている上記(1)ないし(9)のいずれかに記載の静電容量センサ。

【0019】(11) 前記帯電板と前記アース電極との間の距離が、前記帯電板と前記帯電板との間の距離より大きく設定されている上記(1)ないし(10)のいずれかに記載の静電容量センサ。

【0020】(12) 前記検出回路は、前記検出電極の検出面の反対側に設置されている上記(1)ないし(11)のいずれかに記載の静電容量センサ。

【0021】(13) 複数の帯電板が検出素子の厚さ方向に沿って配置されている上記(1)ないし(12)のいずれかに記載の静電容量センサ。

【0022】

【発明の実施の形態】以下、本発明の静電容量センサを添付図面に示す好適実施例に基づいて詳細に説明する。  
【0023】図1は、本発明の静電容量センサの第1実施例を示す側面図である。図面に示すように、静電容量センサ1aは、静電容量型の検出素子(電極部)2と、検出回路が実装された回路基板6と、電極部(真流電極)7とを有している。

【0024】検出素子2は、主に、検出電極3と、帯電板4と、アース電極5とで構成されている。帯電板4は、検出電極3とアース電極5との間に位置し、これら検出電極3、帯電板4およびアース電極5は、互いに絶縁された状態で配置されている。この場合、検出電極3、帯電板4およびアース電極5は、互いに平行であるのが好ましい。

【0025】検出電極3、帯電板4およびアース電極5は、それぞれ、端部において図示しない絶縁材(支持部材)により支持されている。そして、本実施例では、検出電極3と帯電板4との間と、帯電板4とアース電極5との間と、それぞれ、空間が形成されている。

るが、静電容量センサ1aの検出精度が低下するので、これを考慮して、 $L_3$ を適宜決定する。また、同一性能のものを小型のもので適宜得るよう、検出電極3、帯電板4およびアース電極5の面積をほぼ同一とするのが好ましい。

【0040】このような静電容量センサ1aを配置する場合には、取り付け部8の所定の部位に、アース電極5を固定する。この場合、アース電極5は、例えば、取り付け部8や大地に接地される。または取り付け部8等を通じて大地に接地される。

【0041】次に、静電容量センサ1aの検出回路を説明する。図2は、静電容量センサ1aの検出回路の構成例を示すブロック図である。図面に示すように、検出回路60は、パルス信号発生回路61と、抵抗62と、逆動増幅器64と、交流電圧を直流電圧に変換するAC-DC変換器65と、比較器66とで構成されている。

【0042】前記パルス信号発生回路61、抵抗62、逆動増幅器64、AC-DC変換器65および比較器66は、この順序で接続されている。抵抗62の一端側には、検出電極3が接続されている。なお、これら抵抗62および検出電極3(検出素子2)により、減衰器63が構成される。

【0043】パルス信号発生回路61からは、電圧 $v_1$ のパルス信号が出力されている。このパルス信号は、回路61からの出力信号とはにそれぞれ入力される。検出電極3の静電容量(検出素子2の静電容量)Cは、検出電極3が検出電極3の検出面31に接近すると増加し、被検物9が検出電極3の検出面31から遠ざかる減少する。

【0044】減衰器63においては、パルス信号発生回路61からの出力信号を、検出電極3の静電容量Cの値に応じて減衰して出力する。この減衰器63からの出力信号は、逆動増幅器64のプラス側端子に入力される。この場合、減衰器63からの出力信号の電圧、すなわち検出電極3の片端電圧を $v_2$ とする。

【0045】逆動増幅器64は、前記 $v_1$ と $v_2$ との差(差分)を増幅し、電圧 $v_3$ の信号を出力する。この逆動増幅器64からの出力信号は、AC-DC変換器65に人力され、AC-DC変換器65において、交流(交流電圧)から直流(直流電圧)に変換される。この場合、AC-DC変換器65からの出力信号の電圧をVとする。

【0046】AC-DC変換器65からの出力信号は、この比較器66に入力され、予め設定されている所定のしきい値(基準電圧)と比較される。電圧 $v_4$ がしきい値より大きい場合には、ハイレベルの信号(11)が比較器66から出力され、電圧 $v_4$ がしきい値以下の場合には、ローレベルの信号(1)が比較器66から出力される。

【0047】ここで、検出電極3の検出面31に被検物

されている。

【0032】回路基板6を検出電極3の面32に設置するとともに、回路基板6が検出面31と帯電板4との間でコンデンサを形成し、このコンデンサが、直列に接続された複数のコンデンサ(被検物9、検出電極3、帯電板4、アース電極5等で形成された複数のコンデンサ)のうちの1つを構成するので、外部環境の変動による回路基板6の静電容量の変化量が減少し、このため、外部環境の変動による静電容量センサ1aの検出精度の低下が抑制される。

【0033】また、回路基板6を検出電極3の検出面31に取付けないので、検出面31を平面にすることができ、この回路基板6に実装されている検出回路は、電源部7のプラス側端子71およびマイナス側端子72に電気的に接続されており、この電源部7から前記検出回路に電力が供給される。以下、「電気的に接続」を単に「接続」という。なお、検出回路については、後に詳述する。

【0034】ところで、検出電極3の検出面31の面積が $300\text{ cm}^2$ 以上、特に $1000\text{ cm}^2$ 以上、さらには $3000\text{ cm}^2$ 以上の検出素子2を有する静電容量センサの場合には、外部環境の変動による検出電極3の静電容量の変動により、外部環境の変動による検出電極3の静電容量の変動を抑えることができる。

【0035】ここで、検出電極3の検出面31から被検物9までの検出距離(以下、単に「検出距離」という)を $L_1$ 、検出電極3と帯電板4との間の距離を $L_2$ 、帯電板4とアース電極5との間の距離を $L_3$ とする。

【0036】静電容量センサ1aでは、帯電板4とアース電極5との間の距離 $L_3$ が大きい程、検出素子2の感度(静電容量センサ1aの感度)が向上し、検出距離 $L_1$ を大きくすることができ、その理由は、 $L_3$ を大きくすると、帯電板4とアース電極5とで形成されたコンデンサの静電容量が小さくなるので、帯電板4の電荷の放電が抑制され、帯電板4の電荷が検出電極3側に移行し易くなる。これにより、検出電極3には、一定量の電荷が迅速かつ確実に蓄積される。

【0037】このような理由から、帯電板4とアース電極5との間の距離 $L_3$ は、検出電極3と帯電板4との間の距離 $L_1$ より大きく設定するのが好ましく、 $2L_1$ より大きく設定するのがより好ましい。

【0038】また、静電容量センサ1aでは、帯電板4とアース電極5との間の距離 $L_3$ の設定により検出素子2の感度(静電容量センサ1aの感度)を設定し、後述するように、この感度の設定により検出距離 $L_1$ を設定するのが好ましい。

【0039】この場合、帯電板4とアース電極5との間の距離 $L_3$ を大きくする程、検出素子2の感度が向上す

(6)

【0073】この静電容量センサ1fでは、可変コンデンサ15によりその容量を調整することができるので、検出素子2の感度、すなわち検出距離1、を容易に調整することができる。

【0074】また、静電容量センサ1fによれば、前述した静電容量センサ1eと同様に、検出素子2が帯電板4を有しているので、検出素子2自体の感度が向上し、検出距離1を長くすることができることも、外部環境の変動による検出素子2の静電容量の変化量が低減され、これによりS/N比が増大し、静電容量センサ1fの検出精度が向上し、また、静電容量センサ1fの構造にも有利である。

【0075】次に、本発明の静電容量センサの第7実施例を説明する。図8は、本発明の静電容量センサの第7実施例を示す側面図である。なお、前述した静電容量センサ1eとの共通点については説明を省略し、主な相違点を説明する。

【0076】図8に示すように、静電容量センサ1gでは、中継回路11が直列に接続された抵抗12とコンデンサ14とで構成されている。静電容量センサ1gの他の構成は、前述した静電容量センサ1eとほぼ同様である。この静電容量センサ1gでは、前述した静電容量センサ1eと同様に、コンデンサ14の作用により、検出素子2の感度が向上する。

【0077】そして、前述した静電容量センサ1cと同様に、抵抗12の作用により、アース電極5の感度が検出電極3の感度に対して十分に小さくなり、アース電極5が検出電極として機能してしまうのを防止することができ、これにより、検出素子2の感度が安定し、静電容量センサ1gの検出精度が向上する。

【0078】また、静電容量センサ1gによれば、前述した静電容量センサ1eと同様に、検出素子2が帯電板4を有しているので、検出素子2自体の感度が向上し、検出距離1を長くすることができることも、外部環境の変動による検出素子2の静電容量の変化量が低減され、これによりS/N比が増大し、静電容量センサ1gの検出精度が向上し、また、静電容量センサ1gの構造にも有利である。

【0079】次に、本発明の静電容量センサの第8実施例を説明する。図9は、本発明の静電容量センサの第8実施例を示す側面図である。なお、前述した静電容量センサ1gとの共通点については説明を省略し、主な相違点を説明する。

【0080】図9に示すように、静電容量センサ1hでは、中継回路11が直列に接続された可変抵抗13と可変コンデンサ15とで構成されている。静電容量センサ1hのこの他の構成は、前述した静電容量センサ1gとほぼ同様である。

【0081】この静電容量センサ1hでは、可変抵抗13によりその抵抗値を調整することができるので、検出

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3によりその抵抗値を調整（可変設定）することができるので、検出素子2の感度と、その感度の安定性を考慮しつつ、これを容易に調整することができる。

【0064】また、静電容量センサ1dによれば、前述した静電容量センサ1cと同様に、検出素子2が帯電板4を有しているので、検出素子2自体の感度が向上し、検出距離1を長くすることができることも、外部環境の変動による検出素子2の静電容量の変化量が低減され、これによりS/N比が増大し、静電容量センサ1dの検出精度が向上する。

【0065】次に、本発明の静電容量センサの第5実施例を説明する。図6は、本発明の静電容量センサの第5実施例を示す側面図である。なお、前述した静電容量センサ1cとの共通点については説明を省略し、主な相違点を説明する。

【0066】図6に示すように、静電容量センサ1eでは、中継回路11がコンデンサ14で構成されている。静電容量センサ1eのこの他の構成は、前述した静電容量センサ1cとほぼ同様である。

【0067】このようにアース電極5とマイナスイ側端子72との間にコンデンサ14を設けることにより、検出素子2の感度が向上する。特に、帯電板4とアース電極5との間の距離1を一定にしたまま、すなわち1を大きくすることなく、検出素子2の感度を向上させることができるので、静電容量センサ1e（検出素子2）の構造化に有利である。

【0068】静電容量センサ1eでは、コンデンサ14の容量の設定により、検出素子2の感度を設定する。そして、前述したように、この感度の設定により検出距離1を設定するのが好ましい。

【0069】この場合、コンデンサ14の容量を大きくする程、検出素子2の感度が向上するが、静電容量センサ1eの検出精度が低下するので、これを考慮して、コンデンサ14の容量を適宜決定する。

【0070】この静電容量センサ1eによれば、前述した静電容量センサ1cと同様に、検出素子2が帯電板4を有しているので、検出素子2自体の感度が向上し、検出距離1を長くすることができることも、外部環境の変動による検出素子2の静電容量の変化量が低減され、これによりS/N比が増大し、静電容量センサ1eの検出精度が向上する。

【0071】次に、本発明の静電容量センサの第6実施例を説明する。図7は、本発明の静電容量センサの第6実施例を示す側面図である。なお、前述した静電容量センサ1eとの共通点については説明を省略し、主な相違点を説明する。

【0072】図7に示すように、静電容量センサ1fでは、中継回路11が可変コンデンサ15で構成されている。静電容量センサ1fのこの他の構成は、前述した静電容量センサ1eとほぼ同様である。

【0055】また、この静電容量センサ1bによれば、前述した静電容量センサ1aと同様に、検出素子2が帯電板4を有しているので、検出素子2自体の感度が向上し、検出距離1を長くすることができることも、外部環境の変動による検出素子2の静電容量の変化量が低減され、これによりS/N比が増大し、静電容量センサ1bの検出精度が向上する。

【0056】次に、本発明の静電容量センサの第3実施例を説明する。図4は、本発明の静電容量センサの第3実施例を示す側面図である。なお、前述した静電容量センサ1bとの共通点については説明を省略し、主な相違点を説明する。

【0057】図4に示すように、静電容量センサ1cでは、アース電極5が、中継回路11を介して電源部7のマイナスイ側端子72に接続されている。この中継回路11は、その静電容量が検出回路60により検出されないように、検出素子2から所定距離離開して配置するのが好ましい。静電容量センサ1cのこの他の構成は、前述した静電容量センサ1bとほぼ同様である。この静電容量センサ1cの中継回路11は、抵抗（抵抗部）12で構成されている。

【0058】このようにアース電極5とマイナスイ側端子72との間に抵抗12を設けることにより、アース電極5の感度が検出電極3の感度に対して十分に小さくなり、アース電極5が検出電極として機能してしまうのを防止することができる。これにより、検出素子2の感度が安定し、静電容量センサ1aの検出精度が向上する。

【0059】なお、静電容量センサ1cでは、抵抗12の抵抗値が大きいため、検出素子2の感度は安定するが、検出素子2の感度が低下してしまうので、抵抗12の抵抗値は、これを考慮して適宜決定される。

【0060】この静電容量センサ1cによれば、前述した静電容量センサ1bと同様に、検出素子2が帯電板4を有しているので、検出素子2自体の感度が向上し、検出距離1を長くすることができることも、外部環境の変動による検出素子2の静電容量の変化量が低減され、これによりS/N比が増大し、静電容量センサ1cの検出精度が向上する。

【0061】次に、本発明の静電容量センサの第4実施例を説明する。図5は、本発明の静電容量センサの第4実施例を示す側面図である。なお、前述した静電容量センサ1cとの共通点については説明を省略し、主な相違点を説明する。

【0062】図5に示すように、静電容量センサ1dでは、中継回路11が可変抵抗（可変抵抗部）13で構成されている。静電容量センサ1dのこの他の構成は、前述した静電容量センサ1cとほぼ同様である。

【0063】この静電容量センサ1cでは、可変抵抗1

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9が接近すると、検出電極3の静電容量Cが増加し、これにより、検出回路63からの出力信号の電圧 $v_2$ が減少する。そして、電圧 $v_2$ が減少すると、作動増幅器63からの出力信号の電圧 $v_3$ が増加し、AC-DC変換器65からの出力信号の電圧 $v_4$ が増加する。この場合、電圧 $v_4$ がしきい値を超え、ローレベルの信号（L）が検出回路60から出力され、電圧 $v_4$ がしきい値を超えると、ハイレベルの信号（H）が検出回路60から出力される。この検出信号は、被検物9の接近の検出に利用される。

【0048】この静電容量センサ1aでは、検出距離1は、検出素子2の感度と、しきい値との組み合わせにより定まる。この検出距離1の設定や調整は、しきい値を所定値に固定し、検出素子2の感度の設定や調整により行うのが好ましい。その理由は、下記の通りである。

【0049】しきい値を変更し得るようにするためには、比較器66に、しきい値調整用の可変抵抗（可変抵抗は、比較的大きい静電容量を有する）を設置する必要がある。比較的大きい静電容量を有する可変抵抗の存在により、外部環境の変動により、可変抵抗の持つ静電容量の増減がノイズとなり、検出電極3の静電容量Cの検出に悪影響を及ぼすことがあるが、しきい値を所定値に固定する場合には、比較器66の前記可変抵抗を省略することができるので、前記のようなノイズの発生を抑制することができ、これにより静電容量センサ1aの検出精度が向上する。

【0050】以上説明したように、静電容量センサ1aによれば、検出素子2が帯電板4を有しているので、検出素子2自体の感度が向上し、検出距離1を長くすることができることも、外部環境の変動による検出素子2の静電容量の変化量が低減され、これによりノイズに対する信号の割合（S/N比）が増大し、静電容量センサ1aの検出精度が向上する。

【0051】次に、本発明の静電容量センサの第2実施例を説明する。図3は、本発明の静電容量センサの第2実施例を示す側面図である。なお、前述した静電容量センサ1aとの共通点については説明を省略し、主な相違点を説明する。

【0052】図3に示すように、静電容量センサ1bでは、アース電極5が、電源部7のマイナスイ側端子72に接続されている。静電容量センサ1bのこの他の構成は、前述した静電容量センサ1aとほぼ同様である。

【0053】この静電容量センサ1bでは、アース電極5が電源部7のマイナスイ側端子72に接続されていない場合に比べ、アース電極5から電荷を効率的に放電することができるので、アース電極5の感度が向上する。【0054】そして、アース電極5が、空中に存在する電荷の影響や、アース電極5から大地までの間の静電容量（例えば、取り付け台8やその付近の静電容量）の影響を相対的に受けなくなり、静電容量の変動によって生

(5)

材質：アルミニウム合金

寸法：3cm×150cm (450cm<sup>2</sup>)

厚さ：0.2cm

【0104】[アース電極]

材質：アルミニウム合金

寸法：3cm×150cm (450cm<sup>2</sup>)

厚さ：0.2cm

【0105】[検出電極、帯電板およびアース電極の支

持部材]

材質：アクリルニトリル-ブタジエンスチレン共重合

体 (ABS樹脂)

【0106】[検出電極と帯電板との間の距離L<sub>2</sub>]

L<sub>2</sub>：0.2cm

【0107】[帯電板とアース電極との間の距離L<sub>3</sub>]

L<sub>3</sub>：1.5cm

【0108】(実施例2) 帯電板とアース電極との間の

距離L<sub>3</sub>を2.0cmとした以外は実施例1と同様の静電

容量センサ1bを製造した。

【0109】(実施例3) 図9に示す静電容量センサ1

hを製造した。諸条件は実施例2と同様である。

【0110】(比較例1) 帯電板を省略し、かつ、検出

電極の寸法を3cm×3cm (9cm<sup>2</sup>) とした以外は実施例

1と同様の静電容量センサを製造した。

【0111】<実験>実施例1～3および比較例1の静

電容量センサの検出距離L<sub>1</sub>を測定した。なお、検出

電極の比較器66におけるしきい値は、すべて同一値

路60の比較器66におけるしきい値は、すべて同一値

に設定した。また、実施例3の静電容量センサ1hで

は、可変抵抗13の抵抗値を0Ω (可変抵抗13を短

絡)とし、可変コンデンサの容量を500μFおよび1

000μFとした。この結果は、下記表1に示す通りで

ある。

【0112】

【表1】

表 1

	検出電極の 検出面の面積 [cm <sup>2</sup> ]	L <sub>1</sub> [m]	可変コンデンサ の容量 [μF]	可変抵抗の 抵抗値 [Ω]	検出距離L <sub>1</sub> [m]
実施例1	帯電板あり	450	1.5	-	3
実施例2	帯電板あり	450	2.0	-	4
実施例3	帯電板あり	450	2.0	500 1000	8 12
比較例1	帯電板なし	9	-	-	2

【0113】上記表1に示すように、実施例1～3の静

電容量センサは、帯電板を有しているため検出距離L<sub>1</sub>

が大きい。これに対し、比較例1の静電容量センサは、

検出距離L<sub>1</sub>が小さい。

【0114】また、実施例1～3の静電容量センサは、

検出電極の検出面の面積が450cm<sup>2</sup>であるにもかかわらず、検出距離L<sub>1</sub>が一定であり、検出精度が高つ

た。これに対し、比較例1の静電容量センサは、検出電

極の検出面の面積が9cm<sup>2</sup>であるにもかかわらず、検出距離L<sub>1</sub>が小さい。

素子2の感度と、その感度の安定性を考慮しつつ、こ

れらを容易に調整することができる。そして、可変コン

デンサ15によりその容量を調整することができるので、

検出素子2の感度、すなわち検出距離L<sub>1</sub>を容易に

調整することができる。

【0090】また、静電容量センサ1jによれば、前述

した静電容量センサ1hと同様に、検出素子2が帯電板

4を有しているため、検出素子2自体の感度が向上し、

検出距離L<sub>1</sub>を長くすることができる。また、外部環

境の変動による検出素子2の静電容量の変化量が低減さ

れ、これによりS/N比が増大し、静電容量センサ1jの

検出精度が向上し、また、静電容量センサ1jの構造

化にも有利である。

【0091】次に、本発明の静電容量センサの第11実

施例を説明する。図12は、本発明の静電容量センサの

第11実施例を示す側面図である。なお、前述した静電

容量センサ1hとの共通点については説明を省略し、主

な相違点を説明する。

【0092】図12に示すように、静電容量センサ1k

は、検出素子2の構成が前述した静電容量センサ1hと

異なり、その他の構成は、静電容量センサ1hとは同

様である。

【0093】静電容量センサ1kの検出素子2は、2つ

の帯電板、すなわち帯電板 (第1の帯電板) 41および

帯電板 (第2の帯電板) 42と、検出電極3と、アース

電極5とで構成されている。この場合、帯電板41およ

び42は、帯電板41が検出素子3側に位置し、帯電板

42がアース電極5側に位置するように、検出素子2の

厚さ方向 (図12中上下方向) に沿って配置されてい

る。

【0094】なお、静電容量センサ1kでは、検出電極

3と帯電板41との間の距離をL<sub>3</sub>とする。この静電容量セン

サ1kでは、検出電極3と帯電板41とで第1のコンデ

ンサが形成され、帯電板41と帯電板42とで第2のコ

ンデンサが形成され、帯電板42とアース電極5とで第

3のコンデンサが形成されるので、静電容量センサ1h

に比べ、直列に接続されたコンデンサの数が多い。このた

め、静電容量センサ1hに比べ、検出素子2自体の感度

が向上し、検出距離L<sub>1</sub>を長くすることができる。な

に、外部環境の変動によって生じるノイズが減少し、静

電容量センサ1gの検出精度が向上する。

【0095】また、この静電容量センサ1kでは、前述

した静電容量センサ1hと同様に、可変抵抗13により

その抵抗値を調整することができるので、検出素子2の

感度と、その感度の安定性を考慮しつつ、これらを容

易に調整することができる。そして、可変コンデンサ1

5によりその容量を調整することができるので、検出素

子2の感度、すなわち検出距離L<sub>1</sub>を容易に調整するこ

とができる。また、帯電板4とアース電極5との間の距

り

と

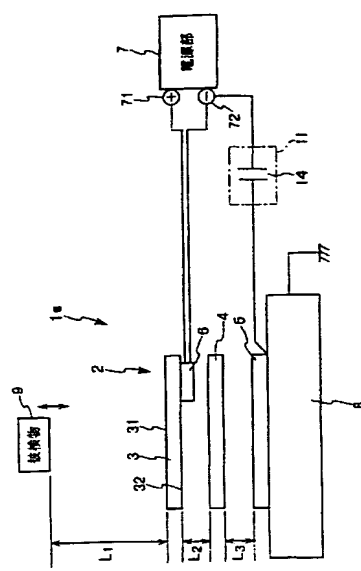
と

と

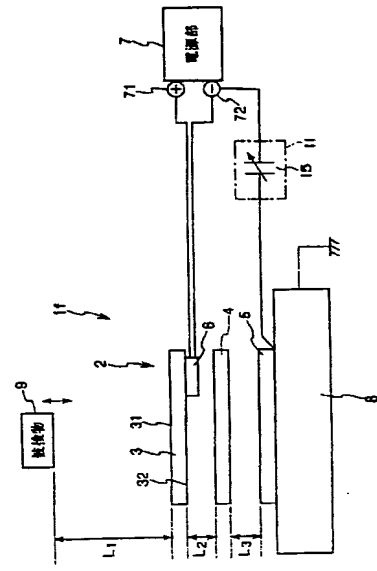
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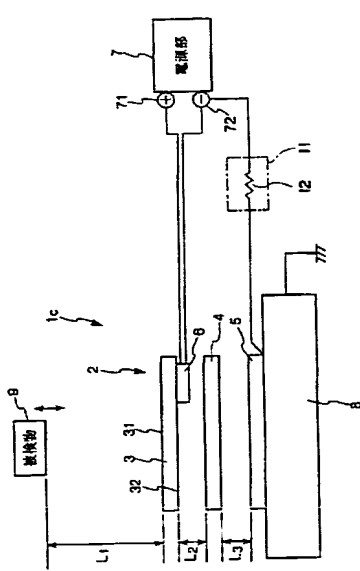
【図6】



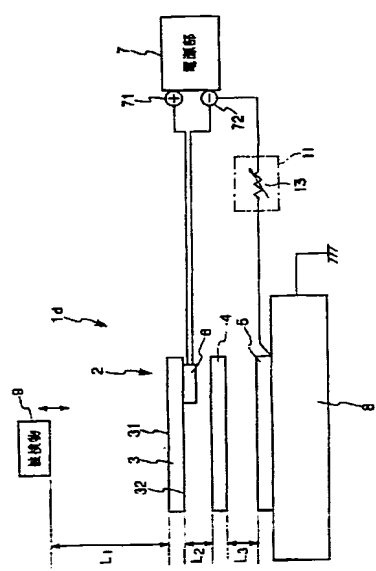
【図7】



【図4】



【図5】









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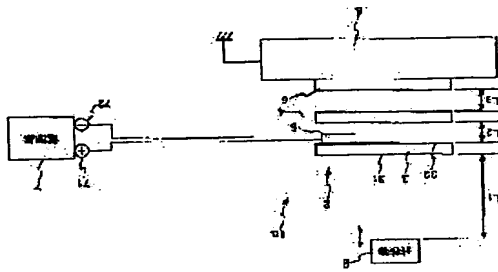
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(21)Application number : 08-257775 (71)Applicant : YASHIMA ENGINEERING KK  
(22)Date of filing : 08.09.1996 (72)Inventor : KATO RYOCHI  
KATO HIDEYO

## (54) CAPACITANCE SENSOR

(57)Abstract:  
PROBLEM TO BE SOLVED: To provide a capacitance sensor having high detection precision and high sensitivity, irrespective of the size of a detection electrode.

SOLUTION: A capacitance sensor 1a is constituted of a capacitance type detection element 1, a circuit board 6 on which a detection circuit is mounted, and a power source part 7. The detection element 2 is constituted of a detection electrode 3, a charged plate 4 and a ground electrode 5. The charged plate 4 is positioned between the detection electrode 3 and the electrode 5. The detection electrode 3, the charged plate 4 and the electrode 5 are arranged in the mutually insulated state, and retained by insulating material (retaining member) in their end portions. The circuit board 6 is arranged on the surface 32 of the detection electrode 3 and insulated from the charged plate 4.



## LEGAL STATUS

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## CLAIMS

[Claim(s)]  
[Claim 1] The electrostatic-capacity sensor characterized by having the sensing element of the electrostatic-capacity mold arranged where at least one electrification plate of each other located between a detection electrode, a ground electrode, and said detection electrode and ground electrode is insulated, the detector which detects change of the electrostatic capacity of said detection electrode by the specimen, and a power supply section for supplying power to said detector.  
[Claim 2] Said ground electrode is an electrostatic-capacity sensor according to claim 1 electrically connected to the minus side edge child of said power supply section.  
[Claim 3] Said ground electrode is an electrostatic-capacity sensor according to claim 1 electrically connected to the minus side edge child of said power supply section through the junction circuit.  
[Claim 4] The electrostatic-capacity sensor according to claim 3 by which said junction circuit has resistance.  
[Claim 5] The electrostatic-capacity sensor according to claim 4 said whose resistance is variable resistance.  
[Claim 6] The electrostatic-capacity sensor according to claim 3 to 5 by which said junction circuit has a capacitor.  
[Claim 7] The electrostatic-capacity sensor according to claim 6 said whose capacitor is a variable capacitor.  
[Claim 8] Said junction circuit is an electrostatic-capacity sensor according to claim 3 which is what has the function to set up the sensibility of an electrostatic-capacity sensor.  
[Claim 9] Said junction circuit is an electrostatic-capacity sensor according to claim 3 or 8 which is what has the function which stabilizes the sensibility of an electrostatic-capacity sensor.  
[Claim 10] The electrostatic-capacity sensor according to claim 1 to 9 constituted by setup of the distance between said electrification plates and said ground electrodes so that the sensibility of an electrostatic-capacity sensor may be set up.  
[Claim 11] The electrostatic-capacity sensor according to claim 1 to 10 by which the distance between said electrification plates and said ground electrodes is set up more greatly than the distance between said detection electrodes and said electrification plates.  
[Claim 12] Said detector is an electrostatic-capacity sensor according to claim 1 to 11 currently installed in the opposite side of the detection side of said detection electrode.  
[Claim 13] The electrostatic-capacity sensor according to claim 1 to 12 by which two or more electrification plates are arranged along the thickness direction of a sensing element.

[Translation done.]

ground electrode is insulated, the detector which detects change of the electrostatic capacity of said detection electrode by the specimen, and a power supply section for supplying power to said detector.

[0010] (2) Said ground electrode is an electrostatic-capacity sensor given in the above (1) electrically connected to the minus side edge child of said power supply section.

[0011] (3) Said ground electrode is an electrostatic-capacity sensor given in the above (1) electrically connected to the minus side edge child of said power supply section through the junction circuit.

[0012] (4) An electrostatic-capacity sensor given in the above (3) said whose junction circuit has resistance.

[0013] (5) An electrostatic-capacity sensor given in the above (4) said whose resistance is variable resistance.

[0014] (6) The above (3) said whose junction circuit has a capacitor thru/or an electrostatic-capacity sensor given in either of (5).

[0015] (7) An electrostatic-capacity sensor given in the above (6) said whose capacitor is a variable capacitor.

[0016] (8) Said junction circuit is an electrostatic-capacity sensor given in the above (3) which is what has the function to set up the sensibility of an electrostatic-capacity sensor.

[0017] (9) Said junction circuit is an electrostatic-capacity sensor the above (3) which is what has the function which stabilizes the sensibility of an electrostatic-capacity sensor, or given in (8).

[0018] (10) The above (1) constituted by setup of the distance between said electrification plates and said ground electrodes so that the sensibility of an electrostatic-capacity sensor may be set up thru/or an electrostatic-capacity sensor given in either of (9).

[0019] (11) The above (1) to which the distance between said electrification plates and said ground electrodes is set more greatly than the distance between said detection electrodes and said electrification plates thru/or an electrostatic-capacity sensor given in either of (10).

[0020] (12) Said detector is an electrostatic-capacity sensor the above (1) currently installed in the opposite side of the detection side of said detection electrode thru/or given in either of (11).

[0021] (13) The above (1) by which two or more electrification plates are arranged along the thickness direction of a sensing element thru/or an electrostatic-capacity sensor given in either of (12).

[0022] [Embodiment of the Invention] Hereafter, the electrostatic-capacity sensor of this invention is explained to a detail based on the suitable example shown in an accompanying drawing.

[0023] Drawing 1 is the side elevation showing the 1st example of the electrostatic-capacity sensor of this invention. As shown in this drawing, electrostatic-capacity sensor 1a has the sensing element (polar zone) 2 of an electrostatic-capacity mold, the circuit board 6 in which the detector was mounted, and a power supply section (DC power supply) 7.

[0024] The sensing element 2 mainly consists of a detection electrode 3, an electrification plate 4, and a ground electrode 5. The electrification plate 4 is located between the detection electrode 3 and the ground electrode 5, and these detection electrode 3, the electrification plate 4, and the ground electrode 5 are arranged in the condition of having insulated mutually. In this case, as for the detection electrode 3, the electrification plate 4, and the ground electrode 5, it is desirable that it is mutually parallel.

[0025] The detection electrode 3, the electrification plate 4, and the ground electrode 5 are supported by the insulating material (supporter material) which is not illustrated in an edge, respectively. And in this example, the opening is formed between the electrification plate 4 and the ground electrode 5 between the detection electrode 3 and the electrification plates 4, respectively.

[0026] In addition, the insulating layer (for example, electric insulating plate) which insulates these mutually may be made to intervene between the detection electrode 3 and the electrification plate 4 in this invention. The insulating layer (for example, electric insulating plate) respectively.

## \* NOTICES \*

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1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. \*\*\* shows the word which can not be translated.
3. In the drawings, any words are not translated.

## DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001] [Field of the Invention] This invention relates to an electrostatic-capacity sensor.

[0002] [Description of the Prior Art] The electrostatic-capacity sensor which detects approach of the specimen is known. The conventional electrostatic-capacity sensor consists of polar zone and a detector connected to this polar zone. Said polar zone consists of a detection electrode for detecting approach of the specimen, and a ground electrode grounded to the predetermined part.

[0003] By such electrostatic-capacity sensor, if the specimen approaches a detection electrode, since the electrostatic capacity of a detection electrode will increase, a detector detects change of the electrostatic capacity of said detection electrode, and this senses approach of the specimen.

[0004] However, since the electrostatic capacity of not only the electrostatic capacity of a detection electrode but the whole polar zone, the electrostatic capacity of a detector, etc. are detected, such electrostatic capacity is moreover changed by change of some external environments, such as temperature, humidity, or vibration, by the electrostatic-capacity sensor in fact and it serves as a noise, detection precision is low. And when an external environment is changed, an electrostatic-capacity sensor may malfunction. Since it changes temperature and humidity sharply according to a season, a time zone or the weather, etc. in using an electrostatic-capacity sensor outdoors especially, detection precision falls further.

[0005] Moreover, that sensibility was unstable while said conventional electrostatic-capacity sensor had the low sensibility of the polar zone itself, and for this reason, it was difficult to lengthen detection distance (only henceforth "detection distance") from a detection electrode to the specimen.

[0006] Fluctuation of the electrostatic capacity of the polar zone by fluctuation of said external environment is large, and since a noise increases by this, the detection precision of an electrostatic-capacity sensor is so low that the area of the detection side of a detection electrode is large especially. And since the threshold in a detector had to be highly set up in order to raise said detection precision when the area of the detection side of a detection electrode was comparatively large, it was difficult to set up detection distance greatly enough.

[0007]

[Problem(s) to be Solved by the Invention] The purpose of this invention has sensibility in offering a high electrostatic-capacity sensor highly [detection precision] irrespective of the magnitude of a detection electrode.

[0008] [Means for Solving the Problem] Such a purpose is attained by this invention of following the (1) - (13).

[0009] (1) The electrostatic-capacity sensor characterized by having the sensing element of the electrostatic-capacity mold arranged where at least one electrification plate of each other located between a detection electrode, a ground electrode, and said detection electrode and

from this power supply section 7. Hereafter, "to connect electrically" is only called "connection." In addition, a detector is explained in full detail behind.

[0034] By the way, the area of the detection side 31 of the detection electrode 3 is 2 30cm. It is especially 100cm above. It is 2 300 morecm above. In the case of the electrostatic-capacity sensor which has the above sensing element 2, it is necessary to make still smaller fluctuation of the electrostatic capacity of the detection electrode 3 by fluctuation of an external environment but, and in this invention, since the sensing element 2 has the electrification plate 4, as mentioned above, fluctuation of the electrostatic capacity of the detection electrode 3 by fluctuation of an external environment can be controlled.

[0035] here -- the detection distance (only henceforth "detection distance") from the detection side 31 of the detection electrode 3 to the specimen 9 -- the distance between L1, the detection electrode 3, and the electrification plate 4 -- the distance between L2, the electrification plate 4, and the ground electrode 5 -- L3 -- -- it carries out.

[0036] At electrostatic-capacity sensor 1a, it is the distance L3 between the electrification plate 4 and the ground electrode 5. The sensibility (sensibility of electrostatic-capacity sensor 1a) of a sensing element 2 improves, so that it is large, and it is the detection distance L1. It can enlarge. The reason is L3. Since the electrostatic capacity of the capacitor formed with the electrification plate 4 and the ground electrode 5 becomes small so that it enlarges, the discharge by the side of the ground electrode 5 of the charge of the electrification plate 4 is controlled, and the charge of the electrification plate 4 becomes easy to shift to the detection electrode 3 side. Thereby, it is accumulated in the detection electrode 3 quickly [ the charge of a constant rate ], and certainly.

[0037] Distance L3 between the electrification plate 4 and the ground electrode 5 since it is such Distance L2 between the detection electrode 3 and the electrification plate 4. It is desirable to be set up greatly and it is 2L2. It is more desirable to be set up greatly.

[0038] Moreover, at electrostatic-capacity sensor 1a, it is the distance L3 between the electrification plate 4 and the ground electrode 5. It is the detection distance L1 by setup of this sensibility so that the sensibility (sensibility of electrostatic-capacity sensor 1a) of a sensing element 2 may be set up by setup and it may mention later. It is desirable to set up.

[0039] In this case, distance L3 between the electrification plate 4 and the ground electrode 5 Since the detection precision of electrostatic-capacity sensor 1a falls although the sensibility of a sensing element 2 improves so that it enlarges, these are taken into consideration, and it is L3. It determines suitably. Moreover, it is desirable to make almost the same area of the detection electrode 3, the electrification plate 4, and the ground electrode 5 so that it may be small and the thing of identity ability can be attained.

[0040] In installing such electrostatic-capacity sensor 1a, it fixes the ground electrode 5 to the predetermined part of the installation section 8. In this case, the ground electrode 5 is grounded on the installation section 8 or the earth, or is grounded through installation section 8 grade on the earth.

[0041] Next, the detector of electrostatic-capacity sensor 1a is explained. Drawing 2 is the block diagram showing the example of a configuration of the detector of electrostatic-capacity sensor 1a. As shown in this drawing, the detector 60 consists of the pulse signal generating circuit 61, resistance 62, differential amplifier 64, an AC-DC converter 65 that changes alternating voltage into direct current voltage, and a comparator 66.

[0042] Said pulse signal generating circuit 61, resistance 62, the differential amplifier 64, the AC-DC converter 65, and the comparator 66 are connected in this sequence. The detection electrode 3 is connected to the end side of resistance 62. In addition, an attenuator 63 is constituted by these resistance 62 and the detection electrode 3 (sensing element 2).

[0043] From the pulse signal generating circuit 61, it is an electrical potential difference v1. The pulse signal is outputted. The output signal from this pulse signal generating circuit 61 is inputted into an attenuator 63 and the minus side edge child of the differential amplifier 64, respectively. The electrostatic capacity (electrostatic capacity of a sensing element 2) C of the detection electrode 3 will increase, if the specimen 9 approaches the detection side 31 of the detection electrode 3, and if the specimen 9 keeps away from the detection side 31 of the detection

which insulates these mutually may be made similarly to intervene between the electrification plate 4 and the ground electrode 5.

[0027] Although especially the configuration of the detection electrode 3 is not limited, it is plate-like in this example. Although the component of the detection electrode 3 will not be limited especially if it is an ingredient which may function as a detection electrode, various metallic materials or an electrical conducting material is usually used for it. As a component of the detection electrode 3, aluminum, an aluminium alloy, copper, a copper alloy, stainless steel, an electric conduction film, electrical conductive gum, electric conduction vinyl, etc. are mentioned, for example.

[0028] Moreover, although especially the configuration of the electrification plate 4 is not limited, it is plate-like in this example. Although the component of the electrification plate 4 will not be limited especially if it is an ingredient which has the function in which charges enough as an electrification plate are charged, various metallic materials or an electrical conducting material is usually used for it. As a component of the electrification plate 4, aluminum, an aluminium alloy, copper, a copper alloy, stainless steel, an electric conduction film, electrical conductive gum, electric conduction vinyl, etc. are mentioned, for example.

[0029] Moreover, although especially the configuration of the ground electrode 5 is not limited, it is plate-like in this example. Although the component of the ground electrode 5 will not be limited especially if it is an ingredient which may function as a ground electrode, various metallic materials or an electrical conducting material is usually used for it. As a component of the ground electrode 5, aluminum, an aluminium alloy, copper, a copper alloy, stainless steel, an electric conduction film, electrical conductive gum, electric conduction vinyl, etc. are mentioned, for example. Moreover, as a component of the insulating material mentioned above and an insulating layer, insulating materials, such as various resin ingredients, are mentioned, for example.

[0030] Thus, in electrostatic-capacity sensor 1a, since the sensing element 2 has the electrification plate 4 A capacitor is formed with the detection electrode 3 and the electrification plate 4, according to the amount of charges accumulated in the detection electrode 3, a charge is applied to the detection electrode 3, or this electrification plate 4 absorbs a charge from the detection electrode 3 to it (the electrification plate 4 functions as the supply / absorption section of the charge to the detection electrode 3). The sensibility is stabilized while the sensibility of sensing element 2 the very thing improves by this, since the charge of a constant rate is always quickly supplied and accumulated in the detection electrode 3.

[0031] Moreover, since two capacitors connected to the serial are formed with the detection electrode 3, the electrification plate 4, and a ground electrode, the electrostatic capacity of the part falls and, therefore, the noise produced by fluctuation of the electrostatic capacity by fluctuation of an external environment (some external environments, such as temperature, humidity, or vibration) is reduced. That is, the signal over the noise produced by fluctuation of an external environment increases comparatively (S/N ratio), and the detection precision of electrostatic-capacity sensor 1a improves. The circuit board 6 is installed in the field 32 of the opposite side of the detection side 31 of the detection electrode 3. In this case, the circuit board 6 is insulated from the electrification plate 4.

[0032] By installing the circuit board 6 in the field 32 of the detection electrode 3, the circuit board 6 forms a capacitor between the detection side 31 and the electrification plate 4. Since this capacitor constitutes one of two or more capacitors (the specimen 9, the detection electrode 3, the electrification plate 4, two or more capacitors formed in the ground electrode 5 grade) connected to the serial The variation of the electrostatic capacity of the circuit board 6 by fluctuation of an external environment decreases, and, for this reason, the fall of the detection precision of electrostatic-capacity sensor 1a by fluctuation of an external environment is controlled.

[0033] Moreover, since the circuit board 6 is not formed in the detection side 31 of the detection electrode 3, the detection side 31 can be made into a flat surface. The detector mounted in this circuit board 6 is electrically connected to the plus side edge child 71 and the minus side edge child 72 of a power supply section 7, and power is supplied to said detector

capacity sensor 1a mentioned above almost. [0053] In this electrostatic-capacity sensor 1b, compared with the case where the ground electrode 5 is not connected to the minus side edge child 72 of a power supply section 7, a charge can be efficiently discharged from the ground electrode 5, and, thereby, the sensibility of a sensing element 2 improves.

[0054] And the noise which the ground electrode 5 stops the effect of the charge which exists in the air, and influencing substantially of the electrostatic capacity (for example, electrostatic capacity of a mount 8 or its neighborhood) of a before [ from the ground electrode 5 / the earth ], and is produced by fluctuation of electrostatic capacity is reduced, and, thereby, the detection precision of electrostatic-capacity sensor 1a improves.

[0055] Moreover, since the sensing element 2 has the electrification plate 4 like electrostatic-capacity sensor 1a mentioned above according to this electrostatic-capacity sensor 1b, the sensibility of sensing element 2 the very thing improves, and it is the detection distance L1. While being able to lengthen, the variation of the electrostatic capacity of the sensing element 2 by fluctuation of an external environment is reduced, a S/N ratio increases by this, and the detection precision of electrostatic-capacity sensor 1b improves.

[0056] Next, the 3rd example of the electrostatic-capacity sensor of this invention is explained. Drawing 4 is the side elevation showing the 3rd example of the electrostatic-capacity sensor of this invention. In addition, explanation is omitted about a common feature with electrostatic-capacity sensor 1b mentioned above, and the main differences are explained.

[0057] As shown in this drawing, in electrostatic-capacity sensor 1c, the ground electrode 5 is connected to the minus side edge child 72 of a power supply section 7 through the junction circuit 11. As for this junction circuit 11, it is desirable to carry out predetermined distance alienation and to arrange from a sensing element 2, so that that electrostatic capacity may not be detected by the detector 60. The other configurations of electrostatic-capacity sensor 1c are the same as that of electrostatic-capacity sensor 1b mentioned above almost. The junction circuit 11 of this electrostatic-capacity sensor 1c consists of resistance (resistor) 12.

[0058] Thus, by forming resistance 12 between the ground electrode 5 and the minus side edge child 72, the sensibility of the ground electrode 5 becomes small enough to the sensibility of the detection electrode 3, and it can prevent that the ground electrode 5 functions as a detection electrode. Thereby, the sensibility of a sensing element 2 is stabilized and the detection precision of electrostatic-capacity sensor 1a improves.

[0059] In addition, in electrostatic-capacity sensor 1c, the sensibility of a sensing element 2 is stabilized so that the resistance of resistance 12 is large, but since the sensibility of a sensing element 2 falls, the resistance of resistance 12 is suitably determined in consideration of these. [0060] Since the sensing element 2 has the electrification plate 4 like electrostatic-capacity sensor 1b mentioned above according to this electrostatic-capacity sensor 1c, the sensibility of sensing element 2 the very thing improves, and it is the detection distance L1. While being able to lengthen, the variation of the electrostatic capacity of the sensing element 2 by fluctuation of an external environment is reduced, a S/N ratio increases by this, and the detection precision of electrostatic-capacity sensor 1c improves.

[0061] Next, the 4th example of the electrostatic-capacity sensor of this invention is explained. Drawing 5 is the side elevation showing the 4th example of the electrostatic-capacity sensor of this invention. In addition, explanation is omitted about a common feature with electrostatic-capacity sensor 1c mentioned above, and the main differences are explained.

[0062] As shown in this drawing, the junction circuit 11 is constituted from variable resistance (variable resistor) 13 by electrostatic-capacity sensor 1d. Other electrostatic-capacity sensor 1d configurations are the same as that of electrostatic-capacity sensor 1c mentioned above almost.

[0063] In this electrostatic-capacity sensor 1c, these can be adjusted easily, taking into consideration the sensibility and the stability of sensibility of a sensing element 2, since variable resistance 13 can adjust that resistance (adjustable setup).

[0064] Moreover, since the sensing element 2 has the electrification plate 4 like electrostatic-capacity sensor 1c mentioned above according to electrostatic-capacity sensor 1d, the

electrode 3, it will decrease.

[0044] In an attenuator 63, the output signal from the pulse signal generating circuit 61 is decreased and outputted according to the value of the electrostatic capacity C of the detection electrode 3. The output signal from this attenuator 63 is inputted into the plus side edge child of the differential amplifier 64. In this case, it is v2 in the electrical potential difference of the output signal from an attenuator 63, i.e., the one end electrical potential difference of the detection electrode 3. It carries out.

[0045] The differential amplifier 64 is said v1, v2 A difference (difference value) is amplified and it is an electrical potential difference v3. A signal is outputted. The output signal from this differential amplifier 64 is inputted into the AC-DC converter 65, and is changed into a direct current (direct current voltage) from an alternating current (alternating voltage) in the AC-DC converter 65. In this case, it is the electrical potential difference of the output signal from the AC-DC converter 65 V4 It carries out.

[0046] The output signal from the AC-DC converter 65 is inputted into this comparator 66, and is compared with the predetermined threshold (reference voltage) set up beforehand. Electrical potential difference v4 A signal (H) high-level when larger than a threshold is outputted from a comparator 66, and it is an electrical potential difference v4. When it is below a threshold, the signal (L) of a low level is outputted from a comparator 66.

[0047] Here, when the specimen 9 approaches the detection side 31 of the detection electrode 3, the electrostatic capacity C of the detection electrode 3 increases, and, thereby, it is the electrical potential difference v2 of the output signal from an attenuator 63. It decreases. And electrical potential difference v2 When it decreases, it is the electrical potential difference v3 of electrical potential difference v2. It increases and is the electrical potential difference v3 of the output signal from the actuation amplifier 63. It increases and is the electrical potential difference v4 of the output signal from the AC-DC converter 65. It increases. In this case, electrical potential difference v4 The signal (L) of a low level is outputted from a detector 60 until it exceeds a threshold, and it is an electrical potential difference v4. If a threshold is exceeded, a high-level signal (H) will be outputted from a detector 60. This detecting signal is used for detection of approach of the specimen 9.

[0048] At this electrostatic-capacity sensor 1a, it is the detection distance L1. It becomes settled with the sensibility of a sensing element 2, and combination with a threshold. This detection distance L1 As for a setup or adjustment, it is desirable that fix a threshold to a predetermined value and a setup and adjustment of the sensibility of a sensing element 2 perform. The reason is as follows.

[0049] In order to enable it to change a threshold, it is the variable resistance for threshold adjustment (variable resistance) to a comparator 66, comparatively large electrostatic capacity - having, although it is necessary to install, fluctuation of the electrostatic capacity which variable resistance has may serve as a noise by fluctuation of an external environment and it may have a bad influence on detection of the electrostatic capacity C of the detection electrode 3. Since said variable resistance of a comparator 66 can be omitted when it fixes a threshold to a predetermined value, generating of the above noises can be controlled and, thereby, the detection precision of electrostatic-capacity sensor 1a improves.

[0050] Since the sensing element 2 has the electrification plate 4 according to electrostatic-capacity sensor 1a as explained above, the sensibility of sensing element 2 the very thing improves, and it is the detection distance L1. While being able to lengthen, the variation of the electrostatic capacity of the sensing element 2 by fluctuation of an external environment is reduced, the signal over a noise increases comparatively (S/N ratio) by this, and the detection precision of electrostatic-capacity sensor 1a improves.

[0051] Next, the 2nd example of the electrostatic-capacity sensor of this invention is explained. Drawing 3 is the side elevation showing the 2nd example of the electrostatic-capacity sensor of this invention. In addition, explanation is omitted about a common feature with electrostatic-capacity sensor 1a mentioned above, and the main differences are explained.

[0052] As shown in this drawing, the ground electrode 5 is connected to the minus side edge child 72 of a power supply section 7 in electrostatic-capacity sensor 1b. The other configurations of electrostatic-capacity sensor 1b are the same as that of electrostatic-

1g, the sensitivity of a sensing element 2 improves according to an operation of a capacitor 14 like electrostatic-capacity sensor 1e mentioned above.

[0077] And it can prevent that the sensitivity of the ground electrode 5 becomes small enough to the sensitivity of the detection electrode 3, and the ground electrode 5 functions as a detection electrode according to an operation of resistance 12 like electrostatic-capacity sensor 1c mentioned above. Thereby, the sensitivity of a sensing element 2 is stabilized and the detection precision which is electrostatic-capacity sensor 1g improves.

[0078] Moreover, since the sensing element 2 has the electrification plate 4 like electrostatic-capacity sensor 1e mentioned above according to electrostatic-capacity sensor 1g, the sensitivity of sensing element 2 the very thing improves, and it is the detection distance L1. While being able to lengthen the variation of the electrostatic capacity of the sensing element 2 by fluctuation of an external environment is reduced, a S/N ratio increases by this, and the detection precision which is electrostatic-capacity sensor 1g improves, and it is advantageous also to thin-shape-izing which is electrostatic-capacity sensor 1g.

[0079] Next, the 8th example of the electrostatic-capacity sensor of this invention is explained. Drawing 9 is the side elevation showing the 8th example of the electrostatic-capacity sensor 1g this invention. In addition, explanation is omitted about an electrostatic-capacity sensor 1g [which was mentioned above] common feature, and the main differences are explained.

[0080] As shown in this drawing, the junction circuit 11 is constituted from electrostatic-capacity sensor 1h by the variable resistance 13 and the variable capacitor 15 which were connected to the serial. Other electrostatic-capacity sensor 1h configurations are the same as that of electrostatic-capacity sensor 1g mentioned above almost.

[0081] In this electrostatic-capacity sensor 1h, these can be adjusted easily, taking into consideration the sensitivity and the stability of sensitivity of a sensing element 2, since variable resistance 13 can adjust that resistance. And since a variable capacitor 15 can adjust the capacity, it is, the sensitivity L1, i.e., the detection distance, of a sensing element 2. It can adjust easily.

[0082] Moreover, since the sensing element 2 has the electrification plate 4 like electrostatic-capacity sensor 1g mentioned above according to electrostatic-capacity sensor 1h, the sensitivity of sensing element 2 the very thing improves, and it is the detection distance L1. While being able to lengthen the variation of the electrostatic capacity of the sensing element 2 by fluctuation of an external environment is reduced, a S/N ratio increases by this, and the detection precision which is electrostatic-capacity sensor 1h improves, and it is advantageous also to thin-shape-izing which is electrostatic-capacity sensor 1h.

[0083] Next, the 9th example of the electrostatic-capacity sensor of this invention is explained. Drawing 10 is the side elevation showing the 9th example of the electrostatic-capacity sensor 1g this invention. In addition, explanation is omitted about an electrostatic-capacity sensor 1g [which was mentioned above] common feature, and the main differences are explained.

[0084] As shown in this drawing, the junction circuit 11 is constituted from electrostatic-capacity sensor 1i by the resistance 12 and the capacitor 14 which were connected to juxtaposition. The other configurations of electrostatic-capacity sensor 1i are the same as that of electrostatic-capacity sensor 1g mentioned above almost. In this electrostatic-capacity sensor 1i, the sensitivity of a sensing element 2 improves according to an operation of a capacitor 14 like electrostatic-capacity sensor 1g mentioned above.

[0085] And it can prevent that the sensitivity of the ground electrode 5 becomes small enough to the sensitivity of the detection electrode 3, and the ground electrode 5 functions as a detection electrode according to an operation of resistance 12. Thereby, the sensitivity of a sensing element 2 is stabilized and the detection precision of electrostatic-capacity sensor 1i improves. [0086] Moreover, since the sensing element 2 has the electrification plate 4 like electrostatic-capacity sensor 1h mentioned above according to electrostatic-capacity sensor 1i, the sensitivity of sensing element 2 the very thing improves, and it is the detection distance L1. While being able to lengthen the variation of the electrostatic capacity of the sensing element 2 by fluctuation of an external environment is reduced, a S/N ratio increases by this, and the detection precision of electrostatic-capacity sensor 1i improves, and it is advantageous also to

sensitivity of sensing element 2 the very thing improves, and it is the detection distance L1. While being able to lengthen, the variation of the electrostatic capacity of the sensing element 2 by fluctuation of an external environment is reduced, a S/N ratio increases by this, and the detection precision which is electrostatic-capacity sensor 1d improves.

[0065] Next, the 5th example of the electrostatic-capacity sensor of this invention is explained. Drawing 6 is the side elevation showing the 5th example of the electrostatic-capacity sensor of this invention. In addition, explanation is omitted about a common feature with electrostatic-capacity sensor 1c mentioned above, and the main differences are explained.

[0066] As shown in this drawing, the junction circuit 11 is constituted from electrostatic-capacity sensor 1e by the capacitor 14. The other configurations of electrostatic-capacity sensor 1e are the same as that of electrostatic-capacity sensor 1c mentioned above almost.

[0067] Thus, the sensitivity of a sensing element 2 improves by forming a capacitor 14 between the ground electrode 5 and the minus side edge child 72. Especially, it is the distance L3 between the electrification plate 4 and the ground electrode 5, L3 [fixing] Since the sensitivity of a sensing element 2 can be raised without enlarging, it is advantageous to thin-shape-izing of electrostatic-capacity sensor 1e (sensing element 2).

[0068] In electrostatic-capacity sensor 1e, the sensitivity of a sensing element 2 is set up by setup of the capacity of a capacitor 14. And as mentioned above, it is desirable to set up the detection distance L1 by setup of this sensitivity.

[0069] In this case, the sensitivity of a sensing element 2 improves so that capacity of a capacitor 14 is enlarged, but since the detection precision of electrostatic-capacity sensor 1e falls, in consideration of these, the capacity of a capacitor 14 is determined suitably.

[0070] Since the sensing element 2 has the electrification plate 4 like electrostatic-capacity sensor 1c mentioned above according to this electrostatic-capacity sensor 1e, the sensitivity of sensing element 2 the very thing improves, and it is the detection distance L1. While being able to lengthen, the variation of the electrostatic capacity of the sensing element 2 by fluctuation of an external environment is reduced, a S/N ratio increases by this, and the detection precision of an external environment is improved.

[0071] Next, the 6th example of the electrostatic-capacity sensor of this invention is explained. Drawing 7 is the side elevation showing the 6th example of the electrostatic-capacity sensor of this invention. In addition, explanation is omitted about a common feature with electrostatic-capacity sensor 1e mentioned above, and the main differences are explained.

[0072] As shown in this drawing, the junction circuit 11 is constituted from electrostatic-capacity sensor 1f by the variable capacitor 15. Other electrostatic-capacity sensor 1f configurations are the same as that of electrostatic-capacity sensor 1e mentioned above almost.

[0073] Since a variable capacitor 15 can adjust that capacity in this electrostatic-capacity sensor 1f, it is, the sensitivity L1, i.e., the detection distance, of a sensing element 2. It can adjust easily.

[0074] Moreover, since the sensing element 2 has the electrification plate 4 like electrostatic-capacity sensor 1e mentioned above according to electrostatic-capacity sensor 1f, the sensitivity of sensing element 2 the very thing improves, and it is the detection distance L1. While being able to lengthen the variation of the electrostatic capacity of the sensing element 2 by fluctuation of an external environment is reduced, a S/N ratio increases by this, and the detection precision which is electrostatic-capacity sensor 1f improves, and it is advantageous also to thin-shape-izing which is electrostatic-capacity sensor 1f.

[0075] Next, the 7th example of the electrostatic-capacity sensor of this invention is explained. Drawing 8 is the side elevation showing the 7th example of the electrostatic-capacity sensor of this invention. In addition, explanation is omitted about a common feature with electrostatic-capacity sensor 1e mentioned above, and the main differences are explained.

[0076] As shown in this drawing, the junction circuit 11 is constituted from electrostatic-capacity sensor 1g by the resistance 12 and the capacitor 14 which were connected to the serial. Other electrostatic-capacity sensor 1g configurations are the same as that of electrostatic-capacity sensor 1e mentioned above almost. In this electrostatic-capacity sensor

sensing element 2 may be three or more.

[0096] Since many capacitors connected to the serial are formed so that there are many electrification plates here, it is so desirable that there are many electrification plates from a viewpoint of improvement in sensibility and improvement in detection precision, but the thickness (the drawing 12 Nakagami down die length) of an electrostatic-capacity sensor will become large, so that there are many electrification plates. When these situations are taken into consideration, as for the number of the electrification plates of a sensing element 2, two to about ten are desirable, and two to about five are more desirable.

[0097] Moreover, it is desirable to form two or more electrostatic-capacity plates like [each electrostatic-capacity sensors 1a-1g other than electrostatic-capacity sensor 1h, and 1i and 1j] electrostatic-capacity sensor 1k mentioned above.

[0098] Although especially the application of the electrostatic-capacity sensor of this invention is not limited, it is applied to various sensors, such as a proximity switch (non-contact switch), a distance robot, a touch sensor, a displacement gage, and a thickness meter, for example.

[0099] And when using the electrostatic-capacity sensor of this invention as a proximity switch, it can prepare in the toilet bowl of an elevator, an escalator, and a toilet, the bumper of a vehicle, a lift device, etc.

[1000] Next, the concrete example of the electrostatic-capacity sensor of this invention is explained.

[Example] Next, the concrete example of the electrostatic-capacity sensor of this invention is explained.

[0101] (Example 1) Electrostatic-capacity sensor 1b shown in drawing 3 was manufactured. The terms and conditions are as follows.

[0102] [Detection electrode]

quality-of-the-material: --- dimension [ of an aluminium alloy detection side ]: --- 3cmx150cm (450cm<sup>2</sup>)

Thickness: 0.2cm [0103] [Electrification plate]

quality-of-the-material: --- aluminium alloy dimension: --- 3cmx150cm (450cm<sup>2</sup>)

Thickness: 0.2cm [0104] [Ground electrode]

quality-of-the-material: --- aluminium alloy dimension: --- 3cmx150cm (450cm<sup>2</sup>)

Thickness: 0.2cm [0105] [Supporter material of a detection electrode, an electrification plate,

and a ground electrode]

Quality of the material: Acrylonitrile-butadiene-styrene copolymer (ABS plastics)

[0106] [Distance L2 between a detection electrode and an electrification plate]

L2 : 0.2cm [0107] [Distance L3 between an electrification plate and a ground electrode]

L3 : 1.5cm [0108] (Example 2) Distance L3 between an electrification plate and a ground

electrode The same electrostatic-capacity sensor 1b as an example 1 was manufactured except having been referred to as 2.0cm.

[0109] (Example 3) Electrostatic-capacity sensor 1h shown in drawing 9 was manufactured.

Terms and conditions are the same as an example 2.

[0110] (Example 1 of a comparison) The same electrostatic-capacity sensor as an example 1 was manufactured except having omitted the electrification plate and having set the dimension of a detection electrode to 3cmx3cm (9cm<sup>2</sup>).

[0111] Detection distance L1 of the electrostatic-capacity sensor of the <experiment> examples 1-3 and the example 1 of a comparison It measured. In addition, all the thresholds in the comparator 66 of a detector 60 were set as the same value. Moreover, the resistance of variable resistance 13 is set to 0ohm (variable resistance 13 is short-circuited) in electrostatic-capacity sensor 1h of an example 3, and it is 500 micro F about the capacity of a variable capacitor. And it could be 1000 micro F. This result is as being shown in the following table 1.

[0112]

[Table 1]

thin-shape-izing of electrostatic-capacity sensor 1i.

[0087] Next, the 10th example of the electrostatic-capacity sensor of this invention is explained. Drawing 11 is the side elevation showing the 10th example of the electrostatic-capacity sensor 1h of this invention. In addition, explanation is omitted about an electrostatic-capacity sensor 1h [ which was mentioned above ] common feature, and the main differences are explained.

[0088] As shown in this drawing, the junction circuit 11 is constituted from electrostatic-capacity sensor 1j by the variable resistance 13 and the variable capacitor 15 which were connected to juxtaposition. The other configurations of electrostatic-capacity sensor 1j are the same as that of electrostatic-capacity sensor 1h mentioned above almost.

[0089] In this electrostatic-capacity sensor 1j, these can be adjusted easily, taking into consideration the sensibility and the stability of sensibility of a sensing element 2, since variable resistance 13 can adjust that resistance. And since a variable capacitor 15 can adjust the capacity, it is, the sensibility L1, i.e., the detection distance, of a sensing element 2. It can adjust easily.

[0090] Moreover, since the sensing element 2 has the electrification plate 4 like electrostatic-capacity sensor 1h mentioned above according to electrostatic-capacity sensor 1j. The sensibility of sensing element 2 the very thing improves, and it is the detection distance L1. While being able to lengthen The variation of the electrostatic capacity of the sensing element 2 by fluctuation of an external environment is reduced, a S/N ratio increases by this, and the detection precision of electrostatic-capacity sensor 1j improves, and it is advantageous also to thin-shape-izing of electrostatic-capacity sensor 1j.

[0091] Next, the 11th example of the electrostatic-capacity sensor of this invention is explained.

Drawing 12 is the side elevation showing the 11th example of the electrostatic-capacity sensor of this invention. In addition, explanation is omitted about an electrostatic-capacity sensor 1h [ which was mentioned above ], common feature, and the main differences are explained.

[0092] As shown in this drawing, unlike electrostatic-capacity sensor 1h in which the configuration of a sensing element 2 mentioned above electrostatic-capacity sensor 1k, other configurations are the same as that of electrostatic-capacity sensor 1h almost.

[0093] The sensing element 2 of electrostatic-capacity sensor 1k consists of two electrification plates (1st electrification plate) 41, i.e., an electrification plate, and an electrification plate (2nd electrification plate) 42, a detection electrode 3, and a ground electrode 5. In this case, the electrification plates 41 and 42 are arranged along the thickness direction (the drawing 12 Nakagami down) of a sensing element 2 so that the electrification plate 41 may be located in a sensing element 3 side and the electrification plate 42 may be located in the ground electrode 5 side.

[0094] In addition, at electrostatic-capacity sensor 1k, it is the distance between L2, the electrification plate 42, and the ground electrode 5 about the distance between the detection electrode 3 and the electrification plate 41 L3 It carries out. At this electrostatic-capacity sensor 1k, since the 1st capacitor is formed with the detection electrode 3 and the electrification plate 41, the 2nd capacitor is formed with the electrification plate 41 and the electrification plate 42 and the 3rd capacitor is formed with the electrification plate 42 and the ground electrode 5, compared with electrostatic-capacity sensor 1h, a serial has many connection \*\*\*\* capacitors. For this reason, compared with electrostatic-capacity sensor 1h, the sensibility of sensing element 2 the very thing improves, and it is the detection distance L1. While being able to lengthen, the noise produced by fluctuation of an external environment decreases, and the detection precision which is electrostatic-capacity sensor 1g improves. [0095] Moreover, in this electrostatic-capacity sensor 1k, these can be adjusted easily, taking into consideration the sensibility and the stability of sensibility of a sensing element 2 like electrostatic-capacity sensor 1h mentioned above, since variable resistance 13 can adjust that resistance. And since a variable capacitor 15 can adjust the capacity, it is, the sensibility L1, i.e., the detection distance, of a sensing element 2. It can adjust easily. Moreover, distance L3 between the electrification plate 4 and the ground electrode 5 Since the sensibility of a sensing element 2 can be raised fixing, it is advantageous also to thin-shape-izing of electrostatic-capacity sensor 1k. In addition, in this invention, the number of the electrification plates of a

表 1

	検出電極の 検出面の面積 [cm <sup>2</sup> ]	L <sub>1</sub> [cm]	可変コンデンサ の容量 [μF]	可変抵抗の 抵抗値 [Ω]	検出面積L <sub>1</sub> [cm]
実施例1	帯電板あり	450	1.5	-	3
実施例2	帯電板あり	450	2.0	-	4
実施例3	帯電板あり	450	500	0	8
			1000	0	12
比較例1	帯電板なし	9	-	-	2

[0113] Since the electrostatic-capacity sensor of examples 1-3 has the electrification plate as shown in the above-mentioned table 1, it is the detection distance L1. It is large. On the other hand, the electrostatic-capacity sensor of the example 1 of a comparison is the detection

distance L1. It is small.

[0114] moreover, the electrostatic-capacity sensor of examples 1-3 -- the area of the detection side of a detection electrode -- 450cm<sup>2</sup> it is -- although -- detection distance L1 It was fixed and detection precision was high. On the other hand, the electrostatic-capacity sensor of the example 1 of a comparison is the detection distance L1, although the area of the detection side of a detection electrode is 2.9cm. There was variation and detection precision was low.

(Example 4)

[0115] When the electrification plate was installed two along the thickness direction of a sensing element and the same experiment as the above was conducted in said examples 1-3,

respectively, it is the detection distance L1. It became still larger and detection precision also improved further.

[0116] As mentioned above, although the electrostatic-capacity sensor of this invention was explained based on each example of illustration, this invention is not limited to these. For example, in this invention, a detector 60 is not limited to the thing of the configuration of illustration.

[0117] Moreover, in this invention, a junction circuit 11 shall not be limited to the thing of the configuration of illustration, i.e., the thing which has the function which stabilizes the sensibility of an electrostatic-capacity sensor, and the thing which has the function to set up the sensibility of an electrostatic-capacity sensor, but shall attain the purpose of arbitration. Moreover, in this invention, the circuit board 6 may be installed in parts other than field 32 of the detection electrode 3 (for example, a rear face, a side face, etc. of the installation section 8).

[0118]

[Effect of the Invention] While according to the electrostatic-capacity sensor of this invention the sensibility of a sensing element can improve and being able to enlarge detection distance since the sensing element has the electrification plate as explained above, the variation of the electrostatic capacity of the sensing element by fluctuation of an external environment is reduced, the signal over a noise increases comparatively (S/N ratio) by this, and the detection precision of an electrostatic-capacity sensor improves.

[0119] When two or more electrification plates are especially arranged along the thickness direction of a sensing element, compared with the case where the number of electrification plates is one, the sensibility of a sensing element is high, and while being able to enlarge detection distance, the detection precision of an electrostatic-capacity sensor is high.

[0120] Moreover, since the discharge by the side of the ground electrode of the charge of an electrification plate is controlled and the charge of an electrification plate becomes easy to shift to a detection electrode side when the distance between an electrification plate and a ground electrode is set up more greatly than the distance between a detection electrode and an electrification plate, the sensibility of a sensing element is high and can enlarge detection



- 7 Power Supply Section
- 71 Plus Side Edge Child
- 72 Minus Side Edge Child
- 8 Installation Section
- 9 Specimen
- 11 Junction Circuit
- 12 Resistance
- 13 Variable Resistance
- 14 Capacitor
- 15 Variable Capacitor

[Translation done.]

\* NOTICES \*

- jp0 and ncipi are not responsible for any damages caused by the use of this translation.
1. This document has been translated by computer. So the translation may not reflect the original precisely.
- 2.\*\*\* shows the word which can not be translated.
- 3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

- [Brief Description of the Drawings]
- [Drawing 1] It is the side elevation showing the 1st example of the electrostatic-capacity sensor of this invention.
- [Drawing 2] It is the block diagram showing the example of a configuration of the detector in this invention.
- [Drawing 3] It is the side elevation showing the 2nd example of the electrostatic-capacity sensor of this invention.
- [Drawing 4] It is the side elevation showing the 3rd example of the electrostatic-capacity sensor of this invention.
- [Drawing 5] It is the side elevation showing the 4th example of the electrostatic-capacity sensor of this invention.
- [Drawing 6] It is the side elevation showing the 5th example of the electrostatic-capacity sensor of this invention.
- [Drawing 7] It is the side elevation showing the 6th example of the electrostatic-capacity sensor of this invention.
- [Drawing 8] It is the side elevation showing the 7th example of the electrostatic-capacity sensor of this invention.
- [Drawing 9] It is the side elevation showing the 8th example of the electrostatic-capacity sensor of this invention.
- [Drawing 10] It is the side elevation showing the 9th example of the electrostatic-capacity sensor of this invention.
- [Drawing 11] It is the side elevation showing the 10th example of the electrostatic-capacity sensor of this invention.
- [Drawing 12] It is the side elevation showing the 11th example of the electrostatic-capacity sensor of this invention.
- [Description of Notations]
- 1a-1k Electrostatic-capacity sensor
  - 2 Sensing Element
  - 3 Detection Electrode
  - 31 Detection Side
  - 32 Field
  - 4, 41, 42 Electrification plate
  - 5 Ground Electrode
  - 6 Circuit Board
  - 60 Detector
  - 61 Pulse Signal Generating Circuit
  - 62 Resistance
  - 63 Attenuator
  - 64 Differential Amplifier
  - 65 AC-DC Converter
  - 66 Comparator